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COMPARISON OF REAL SNOW FENCES WITH MODELS

SNOW RETENTION FENCES IN NAKAYAMA PASS

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CORPS OF ENGINEERS
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE, U.S.A.

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The results of model experiments on snow fences, describing the effect of snow fences designed and installed in the Nakayama Pass region in 1973 are presented.

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COMPARISON OF REAL SNOW FENCES WITH MODELS*
Snow Retention Fences in Nakayama Pass

Yutaka Katada and Sho Yano

1. Introduction

Snow fences are presently used to improve highway traffic conditions, and their results have been satisfactory. However, because there are various extraordinary conditions in this area (topographical, high winds, wind direction, snow drifts, and other obstacles), more efficient snow fences must be developed.

We present here the results of model experiments on snow fences, describing the effect of fences designed and installed in 1973 in the Nakayama Pass region.

2. Description of the Region and the Experimental Equipment

The lines in Figure 1 show the points of the planned snow fence in the Nakayama Pass area within the jurisdiction of the Otaru Development Administration. Since it has been useful for preventing snow drifting on the roads there, Figure 2 shows how the picket-type [see illustration] snow fence was positioned 20 m, 30 m and 30 m from the roadside at a height of 5.5 m.

The climate conditions had approximately 2 m of accumulated snow, a maximum wind velocity of approximately 20 m/sec and a west wind (wind blowing from below).

The mock-up experiment is shown in Figure 3. It consisted of wind tunnel equipment, built and used in Himekomatsu on a scale of 1/400 of the actual line. The height of the snow fence in the model was 13.75 mm.

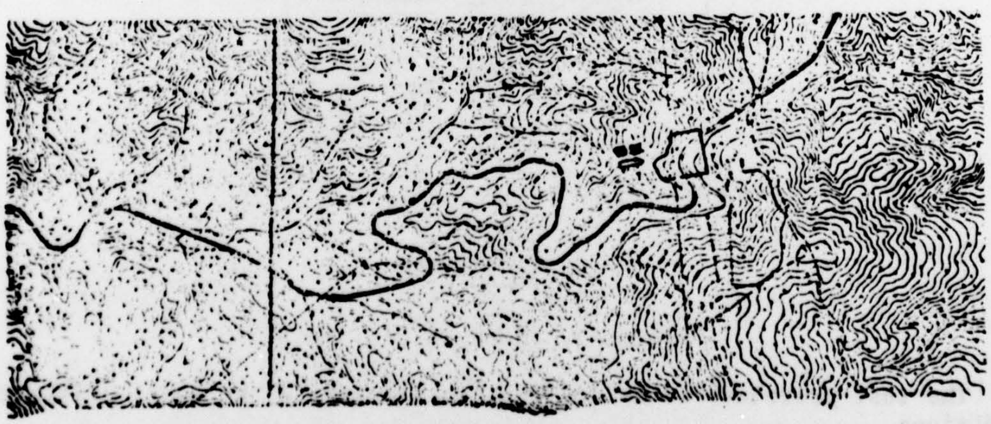

Figure 1. The Snow Fence Region of the Nakayama Pass.

3. Test Equipment and Test Procedure

The test equipment consisted of the 0.8 m x 0.8 m low speed wind tunnel shown in Figure 4, which is located at the Hokkaido developmental construction site, and the model snow making equipment attached to it,

*Bulletin of the 1973 Hokkaido Technical Development Research Conference, No. 17. Research on Snow Retention Fences, no. 2, February 1974.

shown in Figure 5. The dimensions of the wind tunnel are 0.8 m x 0.8 m x x 6 m, with a wind velocity of 0 to 30 m/sec.

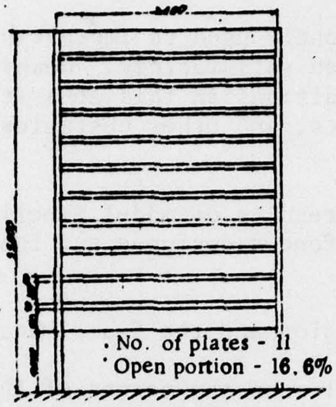

Figure 2. The Picket-Type Snow Fence.

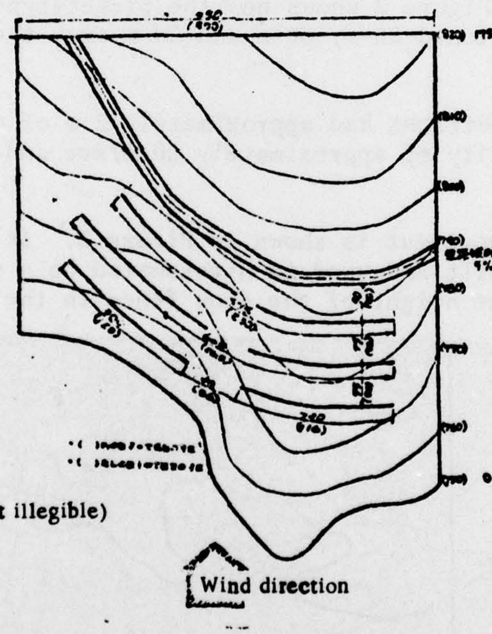

Figure 3. Mock-Up Equipment.

The test procedure is as follows, to illustrate the model drifting conditions.

(1) Drifting Patterns Using Thread

a. Drifting Patterns on the Ground Surface

Figure 6 shows how cellophane was attached to 0.2 mm of thread as a model so that the wind could not blow through. From this we measured the drift patterns on the ground surface.

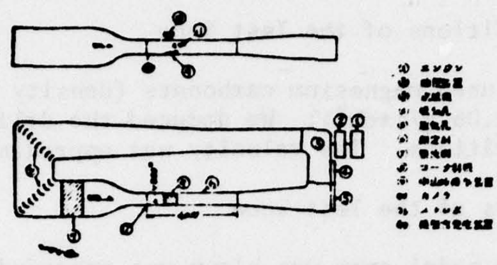

Figure 4. Wind Tunnel Test Equipment. 1, Engine; 2, oil pressure equipment; 3, wind machine; 4-5, blowhole; 6, gauge; 7, [illegible]; 8, cone; 9, Nakayama Pass test equipment; 10, camera; 11, strobe; 12, model snow making equipment.

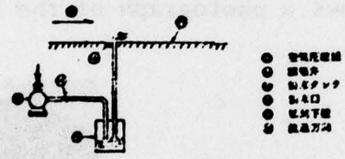

Figure 5. Model Snow Making Equipment. 13, Air pressure gauge; 14, (illegible) valve; 15, powder tank; 16, powder inlet; 17, [illegible]; 18 velocity direction [uncertain].

b. Drift Patterns at the Fence Height

Figure 7 shows how thread with a diameter of 0.2 mm and a length of 20 mm was attached to pins with a diameter of 0.8 mm and a length of 13.7 mm (fence height). This apparatus was omnidirectional.

The direction of the thread and the magnitude of the turbulence was photographed at the points shown in Figure 4 40 to 50 times using a strobe light.

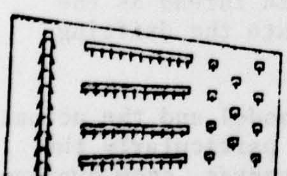

Figure 6. Diagram of the Thread Attached to Cellophane.

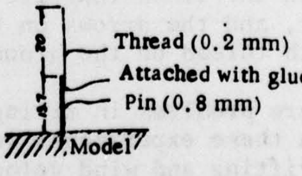

Figure 7. Diagram of the Conditions Where Thread was Attached to Pins.

(2) Drift Patterns in the Test Model Snow

a. Accumulation Conditions of the Test Snow

For the test snow we used magnesium carbonate (density 0.078 g/cm^3 and an adhesive power of 0.06 $g/msec^2$). We deduced the drift patterns from the accumulation conditions. The velocity was approximately 6 m/sec.

b. The Drift Patterns of the Test Snow

The drifting when the model snow was blown was recorded on film.

The fences as shown in Figure 2 were triple fences, but we performed the experiments four times, also using double gences, single fences, and just one fence. The thread tests were conducted with a wind velocity of 3 m/sec.

Figure 8 shows a photograph of the drifting patterns with thread as an example, while Figure 9 shows a photograph of the accumulated test

Figure 8. Drifting Patterns on the Thread.

Figure 9. Drifting Patterns on the Test Snow.

4. Test Results and Discussion

Figures 10 to 13 show the drifting patterns in the case of no fence, single fence, double fence and triple fence. The section where there is a slanted line in the figures indicates the test snow accumulation conditions, the arrows on the lines indicate the drift patterns with thread as the fence height, and the arrows on the dotted lines indicate the drifting patterns with thread on the ground surface.

There are problems in trying to compare the test model and the actual site, but in these experiments we tried to investigate particularly the effect of drifting and wind velocity distribution, blizzards, snow overhangs and topography in nature.

There are conditions in nature where there is effective Re number [1] agreement between drifting wind velocity distribution and that in our wind tunnel, drifting in its turbulence. Here we tried to make sure that there were no height changes in the wind velocity distribution.

The wind velocity and blizzard conditions, as well as the distribution of the blizzard snow and the quality of the snow, must agree as to height from the surface when checking the similarity between actual blizzards and the model. Figure 5 shows how we forced powder from the wind tunnel lower walls and how we blew wind and powder (test snow) into the tunnel [2].

Powder quality is important when checking its effect on snow overhangs. Here we used simple magnesium carbonate, which can be held in the hand, as the powder. In other experiments we used borax [3]. In these experiments the powder should have been able to make overhangs, as is the case in actuality with the wind blowing over the highways. However, it was not possible because of the adhesive power and the irregularity of the ground surface. For example, Figure 10 shows how a certain section of the road did harden. In actual situations this is not possible from blizzards, and we believe that it hardened in the experiments because of the quality of the powder.

The topography affected the pressure gradient [4] of the drifting and the direction of the drifting in cases of carrying [sic] snow. The direction of the drifting could be seen from the direction of the thread, but we could not determine whether there was any quantitative agreement with the drifting pressure gradient.

The snow fence had an opening between the ground surface and the slats, as seen in Figure 2, but the test model did not have any opening in the lower section. This caused large differences in the operation and performance of the open snow fence, and performance results were different when using closed snow fences. This result showed the test snow accumulation in front of and behind the fence.

Even though we could not make strict comparisons as mentioned above, we believe that we could investigate drifting patterns satisfactorily.

Figure 10 shows how we found the drifting directions from the height of the topography because of the direction of the thread.

Figure 10 also shows the test snow accumulation as an obstacle to drifting. This phenomenon is the same in Figures 10 to 13. In the cases of single fences, double fences and triple fences, test snow accumulated behind the fence due to the effect of that fence. The accumulation increased when the turbulence on the thread representing the fence height was compared with other sections. Because there was more turbulence with the triple fence than there was with the double fence, and with the double fence than with the single fence, the test snow accumulation amount increased accordingly.

5. Conclusions

The following results were obtained from the drifting model of the snow fences of Nakayama Pass.

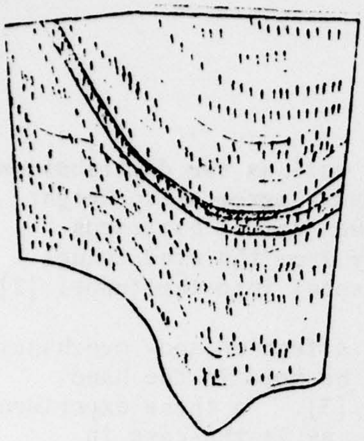

Figure 10. Drifting Patterns with No Fence.

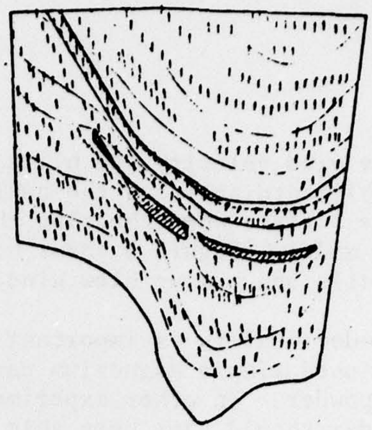

Figure 11. Drifting Patterns with a Single Fence.

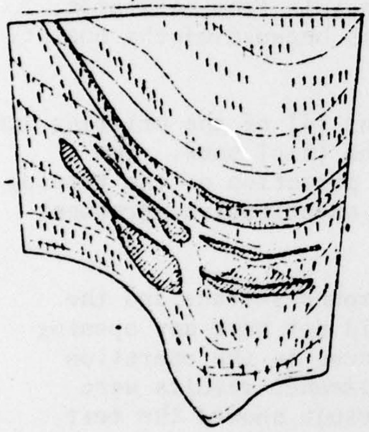

Figure 12. Drifting Patterns with a Double Fence.

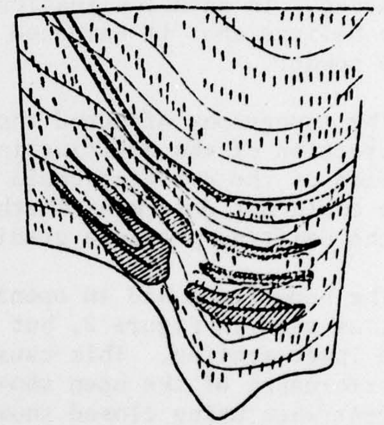

Figure 13. Drifting Patterns with a Triple Fence.

(1) When designing snow fences, the topography must be taken into consideration. This includes the value and direction of the drifting.

(2) A double fence was more effective than a single fence, and a triple fence was more effective that a double fence in preventing drifting from blizzards.

(3) It was possible to check the turbulence and direction of drifting on the ground surface and fence height by checking the thread configuration.

(4) Using model snow it was possible to study accumulation conditions.

Hereafter we are considering proceeding in our surveying research into the relationship between the actual location and the wind tunnel experiment, by going to the snow accumulation area at the site where the snow fences are located, Nakayama Pass.

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